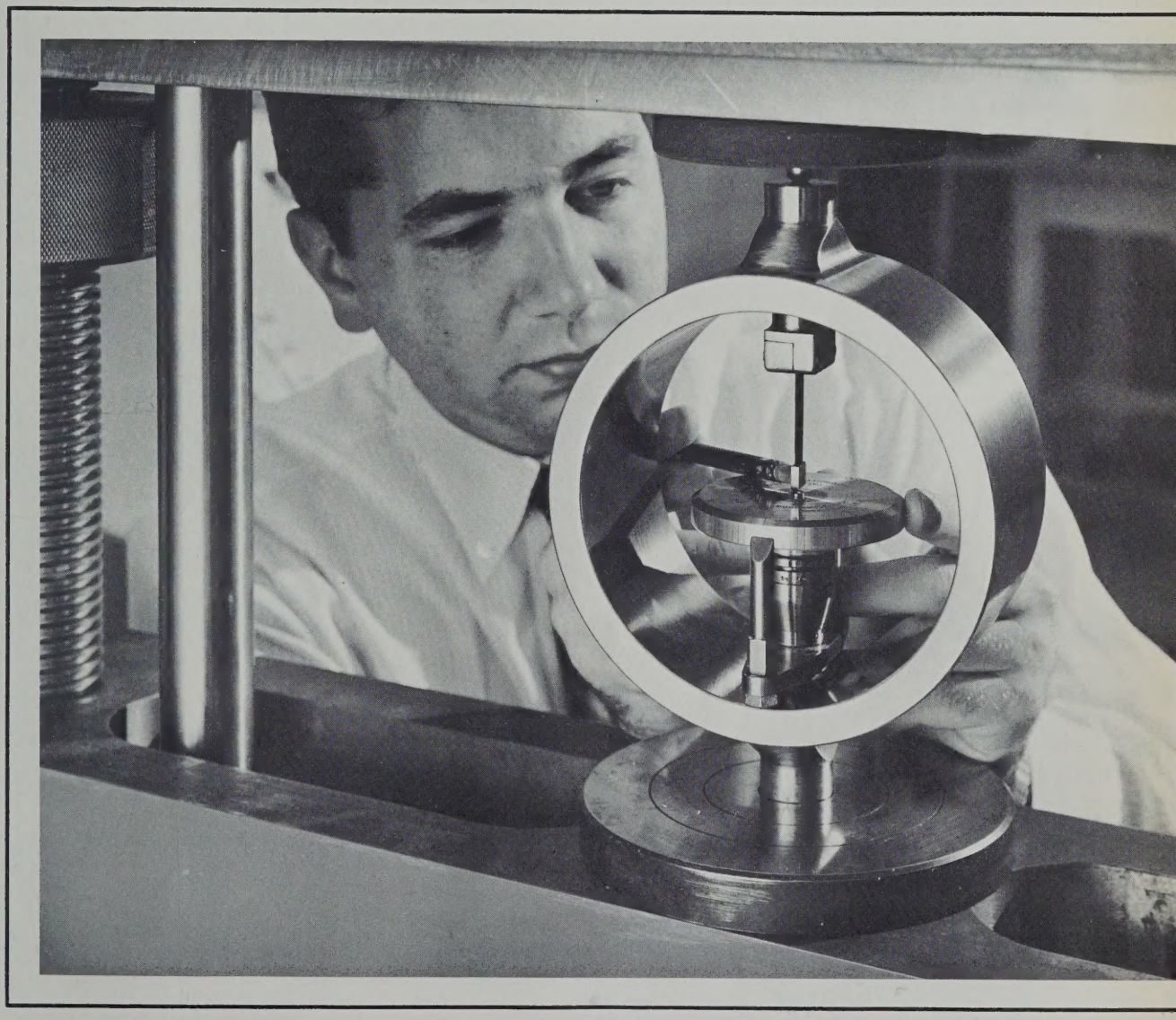
NATIONAL BUREAU OF STANDARDS *February/1968*

Technical News Bulletin



U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

FEBRUARY 1968/VOL. 52, NO. 2/ISSUED MONTHLY

U.S. DEPARTMENT OF COMMERCE
Alexander B. Trowbridge
Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of all three institutes.

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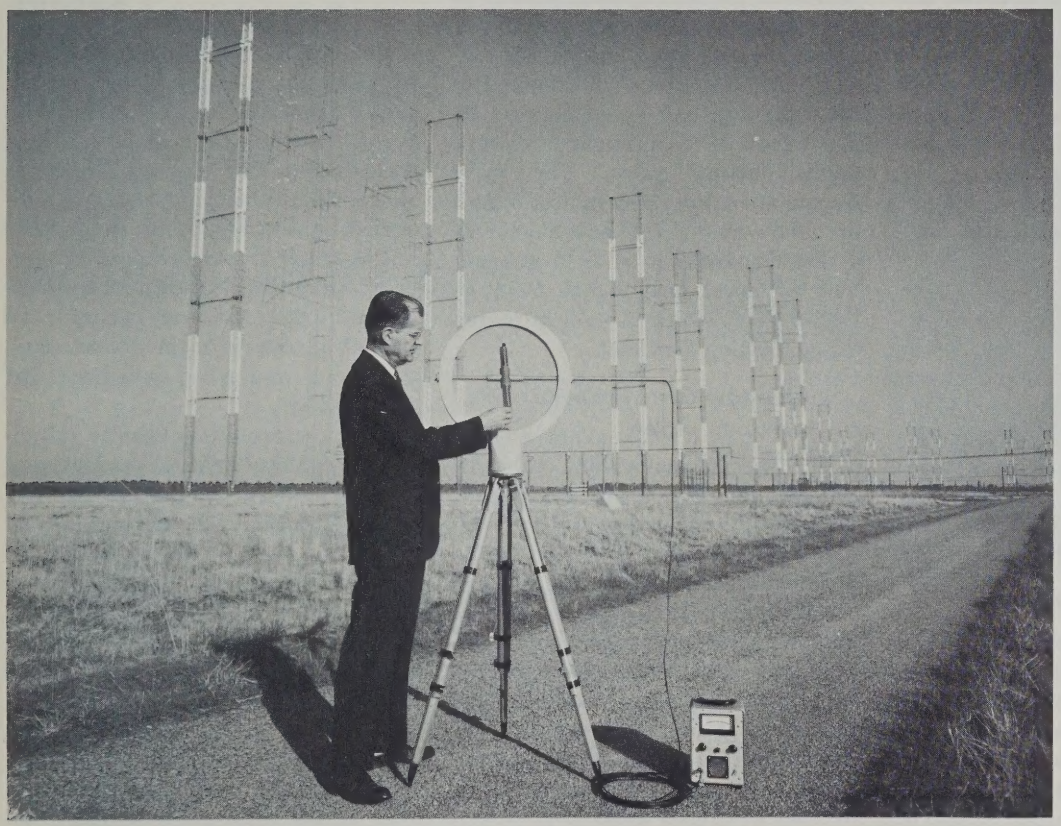
DETONATION DANGER
NEAR ANTENNAS MEASURED



Frank Greene adjusts a radiofrequency field-strength meter for measuring the strength and distribution of a high-level electromagnetic field near a transmitting antenna. The measuring antenna rf unit and the indicator unit on the right are connected by means of specially developed semiconducting transmission line.

NBS System Uses Semiconducting Transmission Line

■ Radiofrequency field strengths from 0.1 to 1000 volts per meter are measured by a novel instrument devised at the NBS Institute for Basic Standards for the Defense Atomic Support Agency (DASA). Portable and internally powered, the system can measure rf fields at frequencies from 150 kHz to 30 MHz as a means of evaluating the danger of detonating ordnance devices or causing biological harm to personnel. The field-strength meter was developed by Frank M. Greene, of the NBS Radio Standards Laboratory at Boulder, Colo., who fabricated a model covering the frequency range of 150–250 kHz and another covering 18–30 MHz. The instruments can be used to measure within two feet of an antenna without unduly perturbing the measured field. This is made possible by using a special semiconducting plastic transmission line developed at NBS to connect the measuring dipole to a remote indicator unit. Because of the extremely high rf line-loss, all rf and calibration circuitry had to be miniaturized and placed, with its associated batteries, inside the measuring antenna.[1]

Hazards Resulting from Rf Fields

The electromagnetic fields near antennas of radio transmitters can cause

continued

DETONATION *continued*

premature detonation of explosives; hence, the admonition at construction jobs, "BLASTING—Turn Off Two-Way Radios." The much stronger fields in the immediate vicinity of powerful military radio transmitters in battle areas and aboard naval ships present a great hazard in handling and storing electro-actuated explosives. Such strong fields have been known to explode shells, damage instruments, and ignite fuel vapors, as well as to possibly cause biological harm to personnel exposed to such fields.

DASA called on NBS to design and produce a meter measuring rf fields from 0.1 to 1000 V/m, a prototype of instruments that could be used at frequencies from 0.15 to 30 MHz. Physical requirements were particularly exacting; the part of the instrument placed in the near field could be no more than a meter in length and had to have a diameter of less than 2 inches. No connecting cable could be used that would alter the field or degrade instrument performance.

Design Features

In the field-strength meter that was developed, perturbing effects on external fields were virtually eliminated by using a specially developed semiconducting plastic transmission line and by designing compact rf components and circuitry that could be enclosed within a hollow dipole measuring antenna. The dipole consists of two 1⅜-inch-diameter copper tubes each about 6½ inches in length. These are positioned end-to-end by a central insulating sleeve.

The suitability of this design for DASA's requirements was demonstrated by two similar prototype rf instruments, one of which included the low-frequency end of the range of interest and the other the upper limit. Each dipole contains a radio receiver consisting of an input capacitive step attenuator, a fixed-tuned, band-pass, rf amplifier, and a detector providing a d-c output in the range from 0.75 to 7.5 V. Each dipole also contains a calibrating oscillator which is tunable over the passband of the receiver and can be switched via a resistive attenuator to the receiver attenuator in place of the antenna. Its unattenuated output is also detected for use in the calibration procedure.

The dipole unit is mounted in a circular polyfoam gimbal ring (transparent to electromagnetic fields), so that the dipole can be oriented to pick up the desired component of the electric field. The dipole is connected to the indicating unit by means of a 30-foot length of the specially developed semiconducting cable. The same transmission line and indicator unit are used with either rf unit to provide a meter indication of field strength and an aural beat signal from its loudspeaker, which is used in tuning the calibrating oscillator.

Semiconductive Transmission Line

The special nonmetallic balanced transmission line connecting the rf unit with the indicating unit is essential to the operation of the NBS near-zone field-strength meter. The material conducting the d-c signal was selected to be midway (on a logarithmic scale of resistance) between a good conductor and an insulator; it has a volume resistivity of approximately 3 ohm-centimeters. It is made by adding (during manufacture) 30 percent (by weight) of carbon black to polytetrafluoroethylene.

A 0.03-inch diameter monofilament of the semiconducting material is coated with a thin layer of nylon and is in turn covered by a woven fiberglass sleeve having an outside diameter of about 0.1 inch. Two such insulated conductors are enclosed side by side in a polyvinyl chloride outer jacket to form the transmission line. The perturbation of the electromagnetic field by this line is more than two orders of magnitude below that caused by copper conductors.

The plastic conductor has a resistance of approximately 20,000 ohms per foot and the transmission line, 1.2 megohms for the 30-foot length. The input resistance of the indicating unit is high—about 200 megohms—so that less than 1 percent of the signal is lost in the transmission line. The line introduces some noise when flexed or moved, but the desired signal is in the 0.75- to 7.5-volt range; therefore, the slight flexural noise is not a problem.

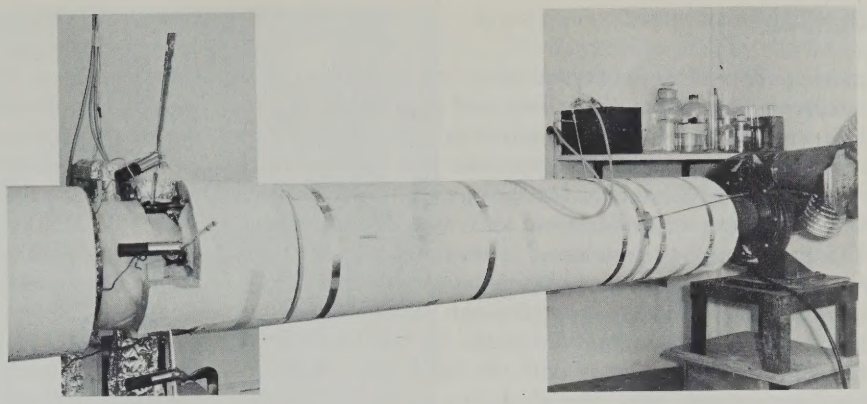
Calibration and Use

The field-strength meter is used by mounting the dipole and gimbal atop a tripod at the desired point in the electromagnetic field. The 30-foot transmission line emerges from the side of the gimbal and runs to the indicator unit, which is positioned further out in the field and facing the operator. Once the indicator unit is properly adjusted, the user performs all further operations at the dipole, using the visual and aural indications of the indicator.

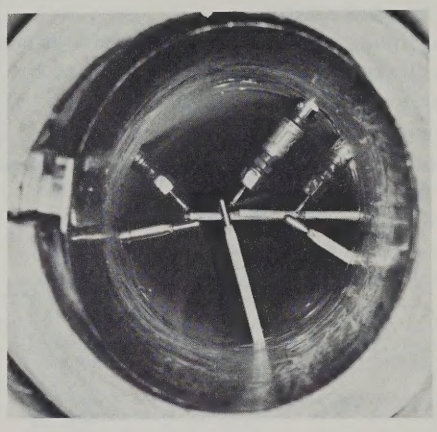
The instrument is calibrated initially in a standard field; any subsequent change in instrument sensitivity can be readily corrected during use by means of a built-in CW oscillator. This is done by tuning the calibrating oscillator, using the audible beat indication, to the desired radiofrequency by means of a knob at one end of the dipole. Then the receiver input is switched from the antenna to the calibrator. The receiver gain is adjusted so that its output is the same as that of the calibrating-oscillator detector, the receiver input is returned to the dipole, and the strength of the unknown signal can then be read directly from the meter.

The present uncertainty of the standard calibrating field developed for these meters is estimated to be less than ±2 dB, and the field-strength measurements are judged to be accurate to approximately the same figure. Continuing development effort on standard fields is expected to reduce this uncertainty to less than ±1 dB.

[1] A New Near-Zone Electric Field-Strength Meter, by F. M. Greene, NBS Tech. Note 345 (Nov. 15, 1966), available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, at a cost of 35 cents.



NBS EVALUATES TEMPERATURE SENSORS FOR AIR MOVING IN DUCTS



Above: An external view of the insulated duct used in this study. Right: An end-on view of the 6-inch experimental air duct shows three sets of temperature sensors, each consisting of a thermocouple, a thermistor, and a thermometer.

■ Studies conducted by J. C. Davis, T. K. Faison, and P. R. Achenbach of the NBS Institute for Applied Technology have shown the need for a moderate relaxing of requirements for measuring the temperature of moving air in laboratory ducts. Such relaxation is particularly applicable for capacity determinations of air-conditioning equipment.

These studies, conducted under isothermal or nearly isothermal conditions, were made with the use of copper-constantan thermocouples, bead-type thermistors, and mercury-in-glass thermometers. During the NBS investigations, comparisons usually showed agreement between the indications of the three types of sensors to within 0.05 deg F when the ten readings of a test run were averaged, and the differences were seldom greater than 0.10 deg F. However, to obtain such agreement, great care in application and observation, which is not usually feasible in the laboratory of many manufacturers, was required. The thermocouple leads, for example, were fixed in a rigid fashion to minimize cold-working of the wire; the same instruments and wires used during testing were used during calibration, and calibrations were made of the thermocouple probes (each having four junctions) after fabrication, rather than depending on the calibration of the wire.

Calibrations were made approximately a year apart for 2 years. There was evidence from the calibrations that the thermocouples drifted by as much as 0.1 deg F from the first to the second calibration, but much less ($\leq$ 0.03 deg F) during the next calibration period. The thermistors exhibited a change of approximately 0.05 deg F between calibrations both years, and the thermometers remained relatively stable, never changing more than approximately 0.04 deg F (0.02 deg C) and usually showing no change.

These studies have resulted in a change in certain accuracy requirements by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). For example, the accuracy requirement for temperature sensors in ASHRAE Standard 41, Temperature Measurement Section, was recently changed from 0.1 to 0.2 deg F. It was correctly maintained that an accuracy of 0.1 deg F was needed to limit the overall error in the measurement of the capacity of an air conditioner to less than 2 percent. Nevertheless, the accuracy to be specified must be limited by what can be accomplished in the laboratory.

The primary purpose of the NBS study was to investigate those factors that tend to reduce the accuracy of temperature sensors under actual conditions of use as compared to the accuracy under conditions of calibration. The performance of the thermocouples, thermistors, and thermometers was observed, in moving air, under isothermal conditions at 55, 75, and 100 °F. The variations in performance of these sensors caused by differences between laboratory conditions of use and the conditions established during calibration were also noted.

The measurements were conducted under idealized conditions in which the temperature differences between the

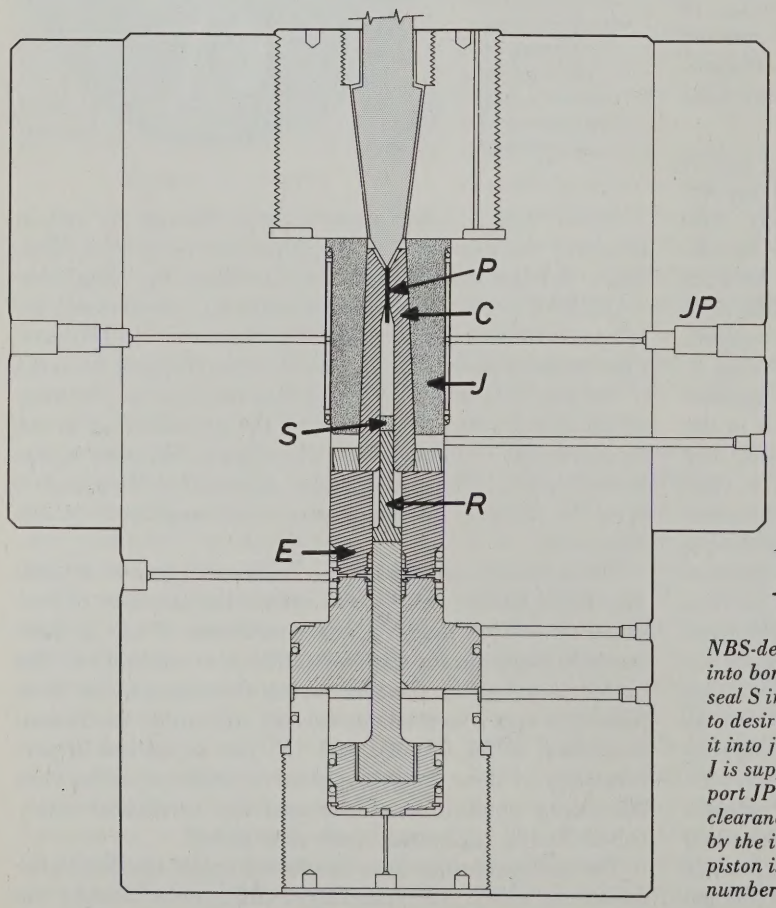
continued

SENSORS *continued*

moving air and the surroundings were minimized. The temperatures of the walls, ceiling, and floor of the laboratory were allowed to reach steady state after about 3 days of controlled temperature before the tests were started. Sometimes 2 or 3 hours of blower operation was required before steady-state conditions of airflow could be obtained. For these tests, two series of measurements were performed: one in which the air whose temperature was measured was forced by a blower through a 6-inch insulated metal duct, and the other in which it was drawn by a blower through the same duct. In both cases, the temperature sensors were placed in the airstream so that a mercury-in-glass thermometer, a thermistor, and a thermocouple were adjacent to each other in each of three selected positions.

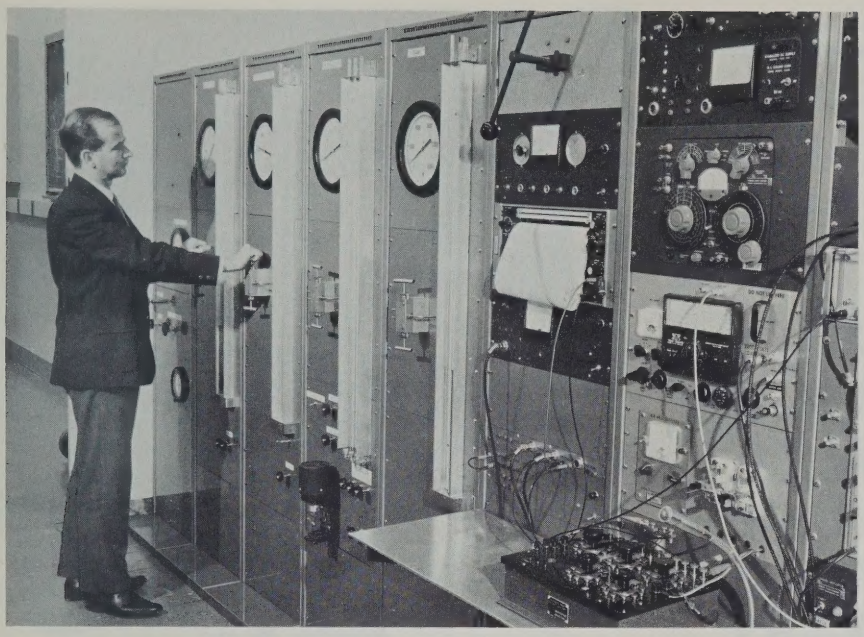
The analysis showed the two largest sources of error during the tests to be the drift of the thermocouples between calibrations and thermal time-constant effects. During a period when there was a lack of steady-state temperature conditions, there was either a serious lag in indication of the mercury-in-glass thermometer or undesirable excursions in the readings of the thermistors. The smaller errors of conduction and radiation, caused by small differences between the temperature of the moving air and the duct wall, and by impact effects, indicated the possibility that a consistent calibration error on the order of 0.05 deg F may have occurred with all sensors. Even smaller errors such as resistance self-heating of the thermistors, parallax in reading the thermometers, and drift in the measuring instruments were considered. Thus in actual practice temperatures in heating and air-conditioning systems cannot be measured consistently to within 0.1 deg F.

Investigations are continuing under nonisothermal conditions where the temperature of the duct wall is 10 to 50 deg F higher than that of the air moving through the duct.



PISTON GAGE DEVELOPED FOR HIGH-PRESSURE MEASUREMENTS

NBS-developed high-pressure piston gage. Piston P fits into bore of high-pressure cylinder C. Ram R pushes movable seal S into liquid-filled sample chamber, increasing pressure to desired value. Ram E supplies end-loading to C and pushes it into jacket J to generate support pressure on its surface; J is supported by pressure in the annular space connected to port JP. This pressure and the ram force control the clearance between P and C. In operation, the force generated by the internal pressure acting on the cross section of the piston is balanced by loading the piston with a sufficient number of weights.



P. L. M. Heydemann stands at the control panel of the high-pressure piston gage.

■ High pressures are being used increasingly in scientific research and industrial processes, creating an urgent need for more precise measurements and calibrations. This need is felt especially in the range up to 30 kilobars or 430,000 psi, the maximum pressure for which apparatus generating hydrostatic pressure is currently available.

For several years the NBS Institute for Basic Standards has been carrying out a program aimed at the development and improvement of high-pressure measurements and standards. As part of this program, a piston gage for accurate pressure measurements up to 26,000 bars has been applied to the accurate determination of the polymorphic phase transition pressures of appropriate materials in this range, including bismuth.[1] These transition pressures may then be used as reference pressures to calibrate high-pressure equipment in the user's plant or laboratory.

Piston gages measure pressure directly as force per unit area. The measurement involves loading a gage piston of accurately known area with enough weights to counterbalance the force generated by the pressure acting upward on the piston. Piston gages are commonly used for pressures up to 3000 bars, and occasionally for pressures above 7000 bars or 100,000 psi. They are the most accurate instruments in this range.

At pressures exceeding 10 kilobars it becomes exceedingly difficult to connect different instruments in the high-pressure system by means of high-pressure tubing. The NBS scientists therefore designed the high-pressure piston gage to include a pressure generator and a large enough inside space to contain the sample immersed in liquid for the necessary measurements.

In the NBS device, a gage piston made of dense, fine-grained, cemented tungsten carbide fits into a 2-mm-diameter bore of a high-pressure cylinder. The lower part of this cylinder is wider and serves as a sample chamber. A ram pushes a movable seal upward into the lower end of the liquid-filled sample chamber, increasing the pressure to the desired value.

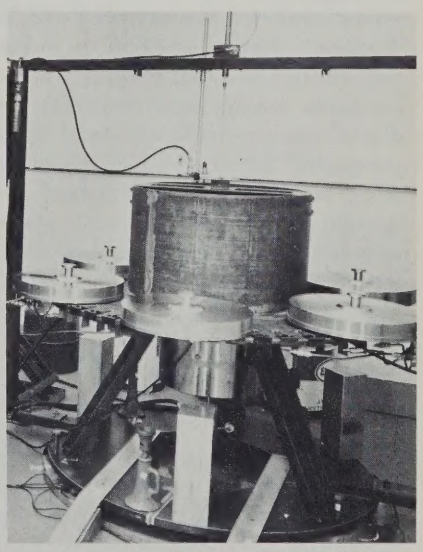
The force generated by the internal pressure acting on the cross section of the piston is balanced by loading the piston with a sufficient number of weights through a pivot resting on the piston. To reach the highest operating pressure of this gage, a total load of 1 ton is balanced on the top of the 2-mm-diameter piston. Piston, pivot, and the entire load are rotated to relieve friction between piston and cylinder. The rotating is accomplished by directing air jets against vanes on the weight holder atop the piston.

The first measurements made with this gage demonstrated the feasibility of the design and also indicated desirable improvements. These measurements have provided a more accurate value for the lowest pressure polymorphic phase transition of a bismuth sample at 25 °C: 25,499, with an estimated uncertainty of ±60 bars.[2] Bismuth is one of the most widely used calibrants in this high-pressure range.

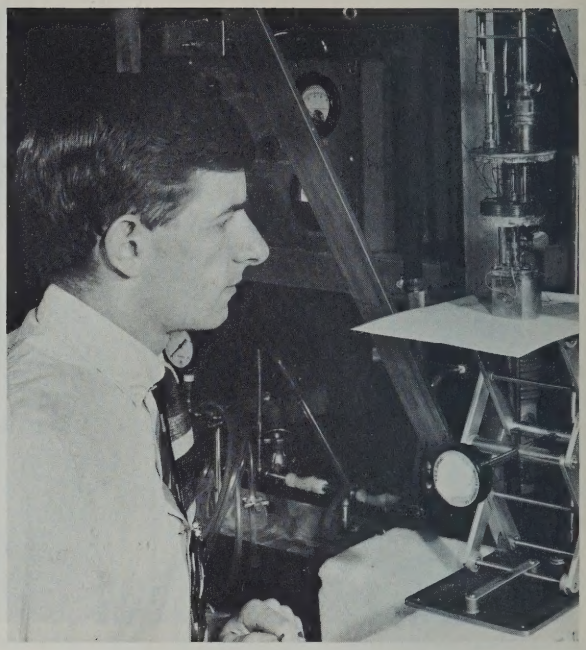
[1] Dead-weight piston gage for pressures to 26 kilobars, by D. P. Johnson and P. L. M. Heydemann, Rev. Sci. Instr. 38, No. 9, 1294 (Sept. 1967).

[2] The Bi I–II transition pressure measured with a deadweight piston gage, by P. L. M. Heydemann, J. Appl. Phys. 38, No. 8, 3424 (July 1967) and J. Appl. Phys. 38, No. 6, 2640 (May 1967).

The 2-mm-diameter gage piston rests on the weight carrier; both are rotated by air jets directed against the vanes under the carrier.



D. B. Utton assembles apparatus used to study nuclear quadrupole resonance thermometry.



NUCLEAR QUADRUPOLE RESONANCE GIVES ACCURATE LOW-TEMPERATURE THERMOMETRY

■ Since nuclear quadrupole resonance (NQR) frequencies were found to be temperature dependent, the idea of a low-temperature thermometer based on this relationship has been suggested by several investigators. Such a thermometer has the advantage that once the frequency-temperature relationship for a particular material has been determined, further calibration of other samples is unnecessary provided the material can be prepared with consistent purity. A further advantage is that frequency measurements readily lend themselves to digital readout techniques and so to processing by computing machines. Also, the broadcast of standard frequency signals by national standards laboratories makes calibration of the frequency-measurement equipment relatively easy.

To facilitate applications of this type of thermometry, D. B. Utton of the NBS Institute for Basic Standards recently investigated the NQR characteristics of chlorine-35 in potassium chlorate over the temperature range from 12 to 297 K.[1] The study has shown that the frequency-temperature relationship in this medium yields precise and accurate low-temperature thermometry.

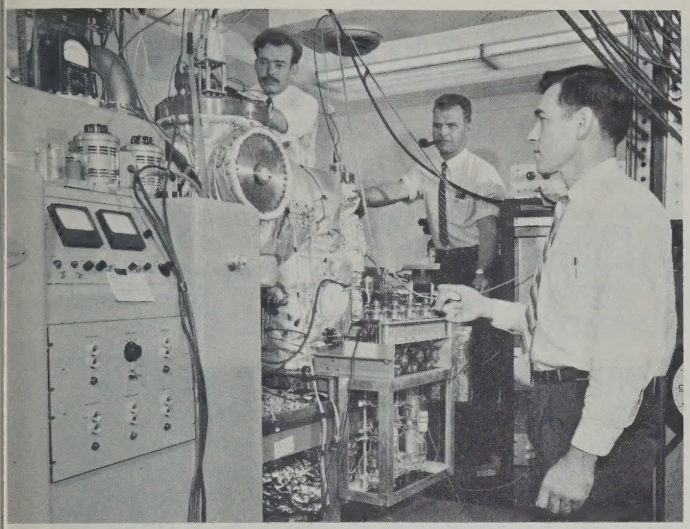
The chlorine resonance frequency, which occurs in the 28-MHz region, results from the interaction of the electric charge on the nucleus with its neighboring electrons. This resonance frequency was determined by a nuclear resonance spectrometer that employed a frequency-modulated oscillator. By sweeping through the resonance frequency with this apparatus the chlorine signal was obtained as the first derivative of an absorption curve. This derivative curve was then used to provide an error signal for a servo system that locked the oscillator frequency to the center of the resonance line.

The apparatus used for cooling and temperature measurements consisted of a copper block with cavities for the specimen (powder) and a platinum resistance thermometer. A radiofrequency coil was attached to the bottom of the specimen cavity and was passed through the powdered sample. The copper block was surrounded by a copper shield, which in turn was surrounded by a brass can. A nickel-iron alloy sheath over the brass can eliminated the earth's magnetic field at the specimen.

The brass can could be immersed in a coolant, or its heat could be removed by a metal heat-conducting strap. Melting ice, solid carbon dioxide, liquid nitrogen, or liquid helium were used as coolants, depending on the temperature required. The temperature of the specimen block, as indicated by the platinum resistance thermometer, could be held constant to within one millidegree over the range 30 to 300 K, for periods ranging from 15 minutes to several hours.

A theoretical expression was fitted to the data obtained in the study from 12 to 90 K by the method of least squares. From 90 to 273 K, a system of polynomials was empirically fitted to the data. Combined uncertainties in the frequency-temperature measurements obtained in the study correspond to ± 0.001 K in the range from 50 to 297 K, deteriorating to ± 0.004 K at 30 K and ± 0.01 K at 20 K.

[1] For further details, see Nuclear quadrupole resonance thermometry, by D. B. Utton, Metrologia 3, No. 4, 98–105 (Oct. 1967).



L. R. Hughey (left) adjusts the voltage while B. J. Waclawski (center) and R. P. Madden (front) monitor the experimental apparatus.

OXYGEN ADSORPTION AFFECTS PHOTOELECTRON YIELD IN THE VACUUM ULTRAVIOLET

■ In recent years it has been realized that very thin layers of surface contamination can drastically affect the observed optical and photoelectric properties of materials in the vacuum ultraviolet (VUV). Because of the high absorptivity of materials for photons whose energy, $h\nu$, is 10 electron volts or greater, there are no suitable "windows" to isolate a detector from the ambient contaminants. Thus, the intensity calibration of the many VUV instruments using photoelectric materials in an open photocathode configuration, such as spectrophotometers, may be seriously impaired by surface contamination—a fact not sufficiently appreciated heretofore.

In an attempt to determine the effect of surface contaminants on the emission process for photoelectrons excited by radiant energy in the VUV, B. J. Waclawski, L. R. Hughey, and R. P. Madden of the NBS Institute for Basic Standards conducted a study on the total photoelectron yield of polycrystalline tungsten as a function of oxygen adsorption at 293 K for several photon energies.[1] By utilizing ultrahigh vacuum techniques to minimize sources of contamination, new features of photoemission in the VUV were observed.

Previous investigators in this spectral region, working with vacua on the order of 10^{-6} torr, have shown that gross contamination of surfaces generally leads to an increase in the photoelectron yield. In contrast, the data obtained in this study show that for comparatively low coverages, on the order of a monolayer, the effect of oxygen alone adsorbed on tungsten is to decrease the yield. Increasing yield occurred only toward higher photon energies.

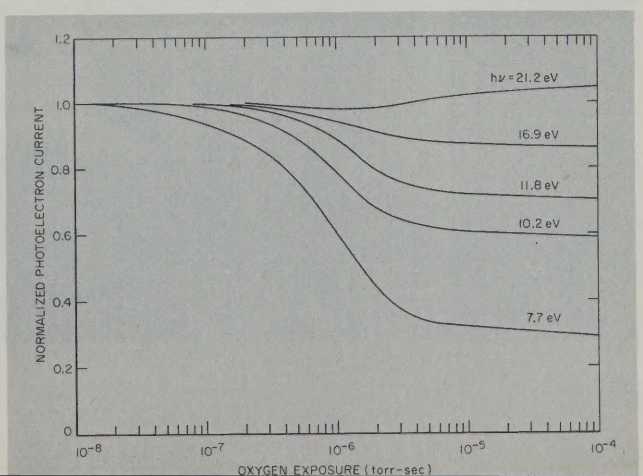
In the NBS study, a vacuum monochromator was coupled, without window materials, to an ultrahigh vacuum chamber which was continuously evacuated. After a chamber bakeout at 623 K, vacua of about 3×10^{-10} torr could be attained with the windowless d-c capillary discharge source in operation. A residual gas analyzer was used to confirm freedom from oil contamination, and to monitor the partial pressure of oxygen which was diffused into the chamber through a heated silver tube. A tungsten ribbon, 9mm x 0.05mm x 19mm active length, served as the cathode of a photodiode and was positioned with its surface normal to the incident beam. The sample could be cleaned by ohmic heating, and was heat treated in oxygen to reduce the carbon content of the tungsten.

In a typical operating sequence, the monochromator was set at a particular wavelength, the source allowed to stabilize, and the sample flashed to about 2200 K for 30 sec. Except for the short initial pressure burst due to the adsorbed oxygen, the vacuum was less than 10^{-9} torr during the flashing time. The photocurrent was measured approximately 15 sec after the end of the flash. Oxygen was then diffused into the chamber to a final pressure of about 5×10^{-8} torr, while the output from the gas analyzer, a voltage proportional to the oxygen partial pressure, was integrated and simultaneously displayed with the photocurrent on an x-y recorder.

Results for photon energies 7.7, 10.2, 11.8, 16.9, and 21.2 eV were obtained showing the variation in photocurrent as a function of total oxygen exposure. It was found that for 16.9 eV, and lower photon energies, the relative yield from tungsten decreased monotonically with oxygen exposure, whereas for 21.2 eV there was an initial decrease

continued on page 34

An NBS study of the effects of oxygen adsorption on the photoelectric yield of tungsten shows a decrease in photoelectric current for the curves for 16.9 eV and below, which is in contrast to results reported by previous investigators.



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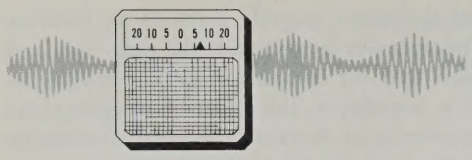


STANDARDS AND CALIBRATION

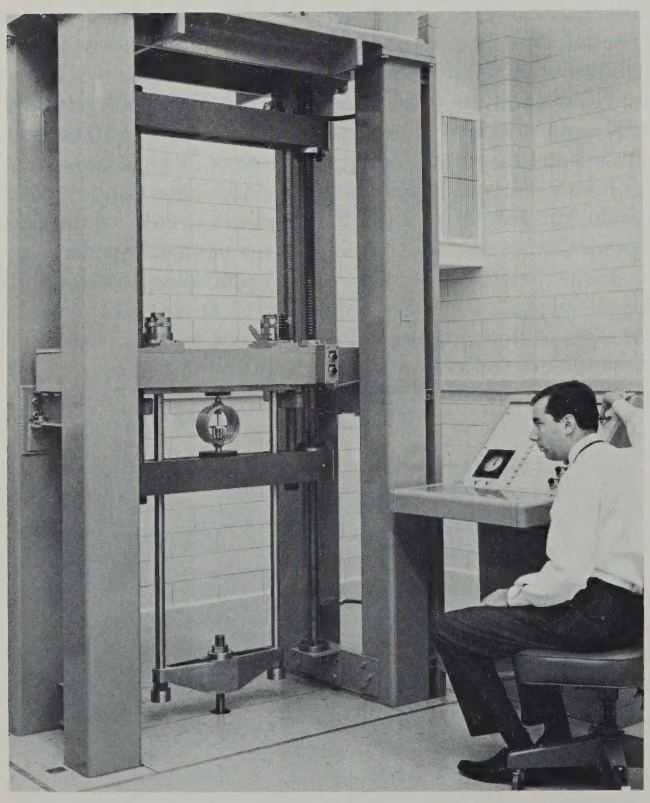
NBS FORCE MEASUREMENT PROGRAM EXPANDED

Two new deadweight machines of 6000-lbf and 25,000-lbf capacities have recently been put into service by the NBS Institute for Basic Standards. These machines supplement existing larger machines of 112,000-lbf, 300,000-lbf, and 1,000,000-lbf capacities. Deadweight machines are used for applying the accurately known forces necessary for the calibration of elastic force-measuring devices such as proving rings and load cells. Such devices are used as reference standards for the calibration of testing machines and for measurements such as rocket thrust.

The new machines differ from the larger machines in that each weight can be applied independently to the device being calibrated. As a result, fewer weights are needed and test loads can be changed more rapidly. With the addition of these new machines, NBS can now apply test loads from 5 to 1,000,000 lbf with load accuracy within 0.002 percent.

Conversion weights were incorporated into the 6000-lbf machine to provide an alternate 3000-kgf range.

Mr. Mallinger, at the control panel, calibrates a proving ring with the new 25,000-lbf deadweight machine.



THREE STATES RECEIVE NEW WEIGHTS AND MEASURES STANDARDS

Oregon, Utah, and California were recent recipients of new weights and measures standards under a program to replace the standards of all 50 States. A. V. Astin, NBS Director, presented a new set of weights and measures standards to Governor Tom McCall of Oregon at a ceremony on October 27, at the new Agriculture Building in Salem; to Governor Calvin L. Rampton of Utah on October 30, at the Department of Agriculture Laboratories, Salt Lake City; and to officials of the State of California, November 22, in Sacramento. With these presentations five States have now received new standards as Ohio and Illinois were presented sets on June 8 and June 9, respectively.

NBS is supervising replacement of the State standards to update and extend measurement competence. Many of the standards and instruments in use by the States in weights and measures administration were provided by the Federal Government as long ago as 100 years or more.

Within the next few months sets will also be presented to Connecticut, Delaware, Kentucky, New Mexico, and Tennessee. It is expected that new standards and instruments will be provided to about 10 States per year until all State standards facilities have been modernized.

Each new set includes standards of mass (weight), length, and volume, and necessary laboratory instruments, including high-precision balances, all specially designed to meet State weights and measures requirements. Each set costs the Federal Government about $70,000, including calibration, installation, and training of laboratory personnel. The State contribution to the program, in the form of new or expanded laboratory facilities and better qualified personnel, will be considerably more than the Federal cost.

Measurement uniformity among the States began in 1838 when Congress authorized the Federal Government to supply each State with ". . . a complete set of weights and measures adopted as standards—to the end that a uniform standard of weights and measures may be established throughout the United States."

In the United States, the actual regulation of weighing and measuring equipment in commerce is retained largely

by the States. The National Bureau of Standards is the principal technical resource for the States in this area.

GEOALERT BROADCAST CODE CHANGED

Beginning January 1, 1968, a new coding system was instituted for GEOALERT broadcasts by National Bureau of Standards radio stations.[1] The new coding system makes possible the dissemination of more detailed information resulting from improved techniques in observation and prediction of geophysical events. Previous codes have been superseded.

GEOALERTS are messages issued daily by the World Warning Agency of the International Ursigram and World Days Service (IUWDS) and are broadcast as a very slow sequence of International Morse Code symbols from stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) on each of the standard radio carrier frequencies. The coded message alerts experimenters and researchers in radio, geophysical, and solar sciences to outstanding solar or geophysical events that are expected to occur that day or which began in the preceding 24-hour period.

Forecasts are made each day at 0400 UT (Universal Time) at the World Warning Agency. GEOALERTS for a given day are first broadcast at 0418 UT on station WWV, then at 0448 UT on station WWVH. These broadcasts are repeated at hourly intervals until the new alert is issued. Each message beginning with the letters GEO in Morse Code shall be understood to mean a solar or geophysical message, and will be followed by the coded information in three sets of letters repeated three times in slow International Morse Code.

The first set concerns either *forecasts* of the solar or geophysical event, or the observation and *prediction* for the next day of a stratospheric warming (STRATWARM). Letters which may occur in the first set and their meaning are as follows: [2]

EEE (.) No alert (NIL)
III (. .) FLARES expected
SSS (. . .) PROTON FLARE expected
TTT (—) MAGSTORM expected
UUU (. . —) FLARES and MAGSTORM expected
VVV (. . . —) PROTON FLARE and MAGSTORM expected
HHH (. . . .) STRATWARM
DDD (— . .) STRATWARM and FLARES expected
BBB (— . . .) STRATWARM and PROTON FLARE expected
MMM (— —) STRATWARM and MAGSTORM expected

The second and third sets of letters pertain to the occurrence of and approximate time of *observed* solar or geophysical events. The coding for the time and type of event is shown in the table given below: [2]

	Day before that of issue (hours UT)				Day of issue	Nil
	00–06	06–12	12–18	18–24	00–04	
Second letter set PROTON EVENT	MMM (— —)	TTT (—)	HHH (. . . .)	SSS (. . .)	III (. .)	EEE (.)
Third letter set GEOMAGNETIC STORM	UUU (. . —)	AAA (. —)	BBB (— . . .)	DDD (— . .)	NNN (— .)	EEE (.)

For example, the following message (in International Morse code)

GEO SSS EEE DDD

signifies:

GEO = Solar or geophysical message
SSS = PROTON FLARE expected
EEE = No PROTON EVENT between 0000 yesterday and 0400 UT today
DDD = GEOMAGNETIC STORM occurred (began) between 1800–2400 UT yesterday

STANDARD FREQUENCY AND TIME BROADCASTS

WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz
WWVH—2.5, 5.0, 10.0 and 15.0 MHz
WWVB—60 kHz

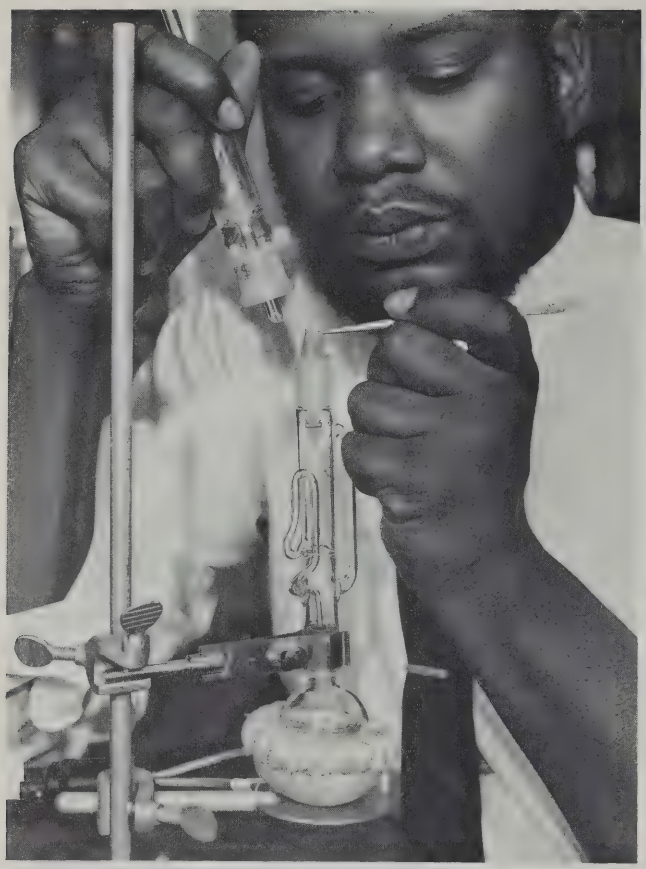
Radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. Adjustments are made at 0000 UT on the first day of a month. *There will be no adjustment made on March 1, 1968.* The pulses occur at intervals that are longer than one second by 300 parts in 10^{10} due to an offset in carrier frequency coordinated by the Bureau International de l'Heure (BIH), Paris, France.

Radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses derived from the NBS Time Standard (NBS–III) with no offset. Step adjustments of 200 ms are made at 0000 UT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be an adjustment made on March 1, 1968. The seconds pulses emitted from WWVB will be retarded 200 ms.*

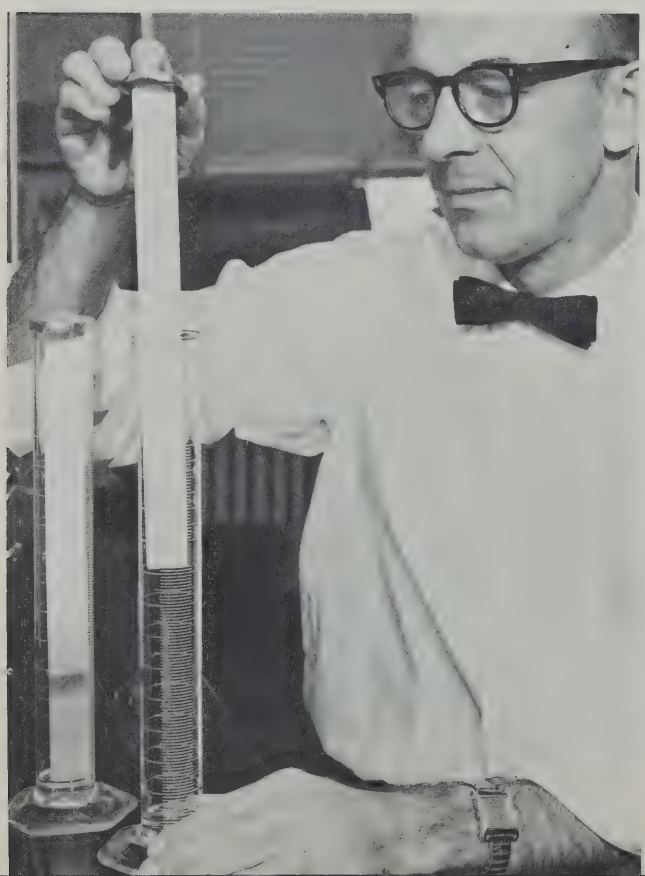
[1] The new coding system is explained in Circular Letter RWC–101, Sept. 13, 1967, International Ursigram and World Days Service, available from Chairman, IUWDS, ESSA, R4.2, Boulder, Colo. 80302.

[2] The International Morse code symbols in parentheses are given for single letters only, i.e., E is one dot, EEE would be three dots separated by the appropriate intervals.

CHROMATOGRAPHIC A



M. Wallace places a sample of colored paper into a refluxing apparatus, which when heated will circulate the solvent and extract the dye from the sample. Subsequent processing separates the dye components for analysis and identification.



S. Toner removes a chromatogram from a graduate containing developing solvent. Components of the sample dye have been carried up the strip by the ascending solvent, each to a different height. The hues present and their heights enable the dye and its constituents to be identified.

■ A method for extracting dye from samples of colored paper and analyzing it by chromatography has been developed by Melvin R. Wallace, Lewis T. Milliken, and Samuel D. Toner of the NBS Institute for Applied Technology. The procedure fills a present need in the paper and textile industries for an analytical method to supplement visual matching. The color separations obtained on the chromatographic strip identify dyes and assist in determining retention of specific dyes in various pulps. This makes the procedure useful to identify components that must be added to compensate for variations in retentivity. Although developed to solve a specific problem at the Bureau's experimental paper mill, the method could aid in solving color-matching problems in other areas as well.[1]

Coloring paper during the manufacturing process might appear to involve nothing more than adding dye to the pulp slurry until the paper produced looks like a matching sample. This is practical for single-component dyes, but many dyes are composed of mixtures of several individual dyes. Slight changes in the characteristics of pulp and dyes (occurring even with material from the same suppliers) can result in changed retentivity for a specific dye component. This can be compensated for by adding dyes to obtain a match by visual comparison, a method that requires much experience and is costly, since paper is being produced continuously by the machine.

The effectiveness of visual comparisons is limited by the fact that we want to match spectra, whereas the eye sees only a sort of average of color peaks. The use of color-sensing instru-

NALYSIS OF DYES IN PAPER

ments to do the seeing is limited because they fail to see color differences visible to the eye or fail to distinguish between similar, but not identical, colors in mixtures.

Extracting Dye From Samples

The chromatographic method of dye analysis works by spatially separating the components of the dye sample on a paper strip so that they can be identified. This is made possible by the fact that as the solvent is drawn up the filter paper strip by capillary action, dissolved dye components also are drawn along, each at its characteristic rate of speed.

Dye and other soluble material are extracted from paper by heating a 1-centimeter-square sample of the paper in a water-butanol-pyridine solvent for an hour. This is done in a refluxing apparatus, which circulates hot solvent around the sample. Then the leached-out square of paper stock is removed, all solvent is evaporated from the extract, and the extract is again dissolved in 0.2 ml of fresh solvent.

A fixed portion of the redissolved dye extract is deposited as a narrow band near one end of a foot-long, inch-wide strip of filter paper. The solvent is then evaporated from the deposit. Next the paper strip is suspended, sample end down, in a graduate containing enough solvent to cover the end of the strip to 1 inch below the sample band. The strip is left this way for 16–17 hours, during which time the solvent is drawn up the strip by capillary action to a point 10 inches above the dye application line. Various components of the dye also are drawn up along with the solvent, each at its characteristic rate, producing single-color stripes across the paper strip. When the strip is removed from the developing cylinder, the solvent front is marked and the strip dried.

Interpreting Chromatograms

The distance a color component has moved above the application line is expressed as its R_f value, the ratio of its travel to that of the solvent; it is specific for this component wherever found and is generally reproducible within ± 0.01 (1 percent) of that component's reference R_f. Dyes used as supplied by the manufacturer produce chromatograms consisting of a reproducible series of color stripes. If these are described by listing the R_f values, for each hue (wavelength), the presence of this dye in samples can be identified by matching hue-R_f listings.

Not all constituents of dyes are normally visible; some can be found only because they fluoresce in the presence of ultraviolet light. The R_f values are listed for the fluorescent hues as for the visible ones and are similarly used in identifying dyes, although they may not contribute to the color seen in normal light.

Reference Dye Samples

Data on commercially formulated dyes can be obtained for comparison and identification of unknown dyes by reference chromatograms made from samples of paper containing these dyes. Because the hue-R_f values for dyes extracted from paper samples are affected by retention by the paper stock for the various components, and because characteristics of both dye and stock obtainable may change slightly over the years, reference samples should be made with the laboratory's own paper stock.

Reference samples were prepared in this study from 36 dyes (15 direct dyes, 11 acid, and 10 basic) used to color paper. All were incorporated at a concentration of 0.5 percent (of dry pulp weight) in bleached sulfite pulp slurry, from which 6½-inch round sheets were made. One-centimeter-square pieces of these samples were used to prepare the reference chromatograms by means of the same procedure used for the unknown samples. Where necessary to evaluate retention, the reference chromatogram was made directly from a dye solution.

Although the size of samples used had been chosen to make possible further instrumental analysis or chemical tests, visual inspection in white and ultraviolet light was found to be sufficient to make identification certain. Even the amounts of dye present could be estimated by comparison with reference chromatograms.

Only the basic dyes were not completely amenable to the chromatographic technique; 5 of the 10 could not be separated, resolved, or identified by the described procedure. Some could not even be completely extracted from the paper sample by refluxing with the water-butanol-pyridine solvent. During development, moreover, some basic dyes moved with the solvent front and remained there, obscured by fluorescent decomposition products normally present. Other solvents investigated were not satisfactory for both extracting the dye from the sample and carrying it up the chromatogram strip.

[1] Identification of dyes in paper by extraction and chromatographic analysis, by M. R. Wallace, L. T. Milliken, and S. D. Toner, TAPPI 50, No. 9, 121A–124A (Sept. 1967).

OXYGEN ADSORPTION *continued*

with a subsequent increase above the clean tungsten yield. Also, the relative change in yield with oxygen exposure was a function of photon energy, and decreased toward higher energies.

The decrease in yield with increasing oxygen coverage has been interpreted as resulting from the known increase in the electronic work function of tungsten during oxygen adsorption. A continuously rising potential barrier at the surface with oxygen coverage would produce a continuously decreasing transmission coefficient for the distribution of photoexcited electrons. Because the energy range of the excited electrons would be greater for the higher energy photons, an equal change in barrier height would have a smaller effect at the higher photon energies.

The 21.2-eV curve, however, shows the onset of an increase in yield with coverage. This increase above the clean tungsten yield has been ascribed to photoelectron emission from the adsorbed oxygen, which is consistent with the photoionization cross section of atomic oxygen and an estimate of the ionization threshhold of oxygen on a tungsten surface.

[1] For further details, see Effect of oxygen adsorption on the photoelectron yield from tungsten in the vacuum ultraviolet, by B. J. Waclawski, L. R. Hughey, and R. P. Madden, Appl. Phys. Letters 10, 305 (1967).

CONFERENCE & PUBLICATION *Briefs*

SEVENTH CONFERENCE ON THERMAL CONDUCTIVITY

The Seventh Conference on Thermal Conductivity met November 13–16, 1967, at the Gaithersburg (Md.) laboratories of the National Bureau of Standards. The seventh in a series of conferences initiated in 1961, this year's conference exceeded those of previous years both in attendance and in the number of papers presented. Approximately 180 scientists and engineers, representing governmental and industrial interests in the United States, Canada, France, Germany, Israel, Italy, Switzerland, and the United Kingdom, heard aproximately 90 technical papers on various aspects of heat conduction in solids, liquids, and gases.

The National Bureau of Standards sponsored the Conference, which was organized by D. R. Flynn and B. A. Peavy of the NBS Institute for Applied Technology. Shirleigh Silverman, NBS Associate Director for Academic Liaison, welcomed the attendees on behalf of the Bureau. At a banquet held on Tuesday night, November 14, Lawrence M. Kushner, Deputy Director of the NBS Institute for Applied Technology, spoke on "Some Elements of the Changing Environment for Science and Engineering."

The Conference was divided into thirteen formal technical sessions:

- Introductory Session
- Methods and Mathematical Analysis
- Metals: Intermediate Temperatures
- Theory—Mainly Phonons
- Metals: Very Low Temperatures
- Metals: Intermediate and High Temperatures
- Non-Metallics and Graphites
- Building Elements, Rocks, and Soils
- Two-Phase Systems
- Nuclear Materials
- Gases
- Liquids
- Thermal Contact Conductance

The introductory session was concerned with the current status of knowledge regarding the thermal conductivity of various well-defined materials. In particular, the session covered those materials that might be used as thermal conductivity reference standards. Of considerable interest in this session was a paper by A. E. Wechsler (Arthur D. Little, Inc.) and M. L. Minges (Air Force Materials Laboratory) describing the status of an Air Force-sponsored investigation having as its objective the establishment of high-temperature thermal-conductivity and thermal-diffusivity standards. The materials selected in this program were aluminum oxide, thorium oxide, arc-cast tungsten, and two commercial graphites.

At this conference proportionately fewer papers were devoted to methods of measurement than was the case at the earlier conferences in this series. A majority of the papers presented data obtained using previously described experimental techniques. Many included analysis of the data in terms of theoretical models or existing physical theory.

Among those papers that were devoted to experimental techniques or to analysis of measurement methods was a particularly interesting group of three papers by C. Codegone and his coworkers (Polytechnio di Torino, Turin, Italy) which described the theory and practice of the techniques they employed to measure thermal diffusivity. A

related paper was presented by E. K. Haltemann and R. W. Gerrish (Pittsburgh Corning Corp.).

A very comprehensive paper by D. R. Tree and W. Leidenfrost (Purdue University) analyzed the sources of error in measuring the thermal conductivity of gases and liquids in a "calorimeter-type cell."

I. Kudman (RCA) showed that the phenomenological model of Abeles can be used to describe the variation of thermal conductivity of semiconductor alloys (GaAs-InAs, GaSb-GaAs, and GaSb-InSb) as a function of composition.

M. J. Laubitz (National Research Council, Ottawa) presented data on the transport properties of two platinum-palladium-gold alloys and one palladium-gold alloy in the temperature range 300 to 1200 K. He then compared the Lorenz functions of these alloys with literature values for platinum, palladium, and a platinum-rhodium alloy. The deviations from the theoretical Lorenz number were unexplainable and indicate that more data are required.

Two papers were given on the thermal conductivity of chromium. J. F. Goff (Naval Ordnance Laboratory) presented thermal conductivity data for chromium which, when compared with higher temperature literature data, indicate a discontinuity in the thermal conductivity at the Néel temperature. J. P. Moore, R. K. Williams, and D. L. McElroy (Oak Ridge National Laboratory), on the contrary, found the thermal conductivity of chromium to have a broad, shallow minimum, but no discernible discontinuity, at the Néel temperature. Additional measurements by a third laboratory appear necessary.

Among the papers on gases was one given by B. Vodar (Centre National de la Recherche Scientifique, Paris) on recent developments at Bellevue on thermal conductivity measurements of compressed gases and one by C. S. Lee and C. F. Bonilla (Columbia University) on the thermal conductivity of alkali metal vapors and of argon.

E. McLaughlin (Louisiana State University) discussed the theoretical aspects of the pressure and temperature dependence of the thermal conductivity of liquids.

In the session on two-phase materials, there were several papers on powders and fibrous materials. T. T. Jones (Monsanto Chemicals Ltd., Newport, U.K.) gave an excellent paper on the effect of thickness and temperature on heat transfer through foamed polymers. G. J. Trezek and D. Jewett (University of California, Berkeley) described some recent measurements of the thermal diffusivity of *in vivo* brain tissue.

Most of the papers in the session on thermal contact conductance were oriented toward correlation of contact conductance with the properties of the surfaces involved. L. Wolf, Jr., and C. Kostenko (IIT Research Institute, Chicago) described a preliminary study of the feasibility of correlating ultrasonic transmittance and thermal conductance of mechanical interfaces in vacuum.

The proceedings of the Seventh Conference on Thermal Conductivity will be published by the National Bureau of Standards and should be available early this summer from the Superintendent of Documents, U.S. Government Printing Office.

The Eighth Conference on Thermal Conductivity will be held in the fall of 1968 under the sponsorship of the Thermophysical Properties Research Center, Purdue University, West Lafayette, Ind.

MASS MEASUREMENT LECTURES PUBLISHED

A condensed version of lectures on errors of measurement presented at the NBS Precision Measurement Seminar on Mass Measurement in the winter of 1964 has been published by the National Bureau of Standards in the form of a 17-page booklet. The Seminar took place at the NBS Washington, D.C., laboratories and the lectures were given by P. E. Pontius, Chief of the Mass and Volume Section, and J. M. Cameron, Chief of the Statistical Engineering Laboratory, both of the NBS Institute for Basic Standards.

Issued as NBS Monograph 103, *Realistic Uncertainties and the Mass Measurement Process—An Illustrated Review*, the booklet is available at 20 cents per copy from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The lectures review the process of measuring mass from the initial basic concept to the statement of a measured mass value, examining in more or less detail certain important elements which are apt to be misunderstood, or perhaps misused. The importance of viewing measurement as a production process is emphasized and methods of evaluating process parameters are presented. The use of one of the laboratory's standards as an additional unknown in routine calibration provides an accuracy check and, as time goes on, the basis for precision and accuracy statements.

CONFERENCE ON STOCHASTIC PROCESSES IN CHEMICAL PHYSICS

Arrangements are nearly complete for a Conference on Stochastic Processes in Chemical Physics, sponsored by the University of California, San Diego, and the National Bureau of Standards, with support from the Advanced Research Projects Agency of the Department of Defense. It will meet March 18 to 22, 1968, at the University of California in San Diego. Planning the conference are K. A. Brueckner, J. E. Mayer, and B. H. Zimm of UCSD, I. Oppenheim of MIT, and K. E. Shuler of NBS. Their aim is to bring together world experts in probability theory, applied mathematics, transport processes, statistical mechanics, chemical kinetics, polymer chemistry, and molecular biology for an exchange of ideas and to stimulate activity in the application of stochastic process theory to problems in chemical physics.

About a dozen invited papers and 20 contributed ones will be presented. Attendance is by invitation and, with few

continued

exceptions, all outstanding leaders in the field are expected to be among the approximately 90 participants. Invited papers will be brought from the Universities of London, Tokyo, and Utrecht, the Free University of Brussels, the Instituut-Lorenz (Leiden), and from the National Institutes of Health and other U.S. centers of research.

Topics to be discussed include: Probabilistic and physical approaches to the theory of stochastic processes; relaxation processes in gases, liquids, and solids; chemical rate processes; transport processes; biophysical rate processes; percolation problems; phase transitions; polymerization; random walks on lattices, and Brownian motion.

SYMPOSIUM ON MECHANICAL AND THERMAL PROPERTIES OF CERAMICS

The Bureau will host a Symposium on Mechanical and Thermal Properties of Ceramics at its Gaithersburg site on April 1 and 2, 1968. To be held under the joint sponsorship of the American Ceramic Society, the American Society for Testing and Materials, and NBS, the Symposium will concentrate on the dependence of properties on microstructure and composition. The meeting should thus provide a basis for the understanding of various design and processing problems and aid in the proper selection and use of ceramic materials.

Sessions will treat properties primarily of interest for structural and/or high-temperature applications. The properties to be discussed are: melting points, thermal expansivity and conductivity, emissivity, and deformation. Mechanical testing and fracture of ceramics and the viscoelasticity of glass also will be included as session topics.

The program is intended not only for engineers and physical scientists in the field, but also for those whose specialties are in fields other than ceramics. Those who attended the one-day Symposium on Ceramic Materials and Their Properties held at the Bureau in October 1966 will find the present Symposium to be a followup to that meeting.

Preprints of the papers will be distributed at the Symposium. The proceedings will be published by NBS and made available through the U.S. Government Printing Office.

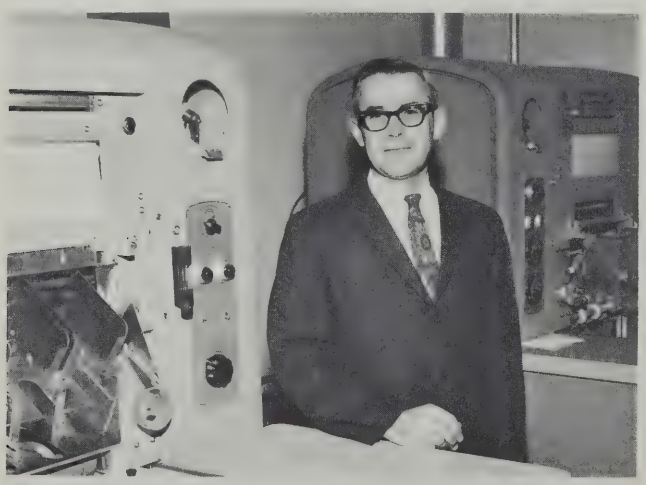
Those desiring further information should write to:

J. B. Wachtman, Jr.
Rm. A359, Materials Bldg.
National Bureau of Standards
Washington, D.C. 20234

A registration fee of $20, payable to "Ceramics Symposium," may be mailed to Dr. Wachtman in advance of the meeting. Reservations with the official headquarters hotel (Sheraton-Park Hotel, Washington, D.C. 20008) should be made directly with the hotel before March 15; when making reservations indicate your attendance at this Symposium.

SAUTER NAMED CLEARINGHOUSE DIRECTOR

H. E. Sauter, recently appointed Director of the NBS Clearinghouse for Scientific and Technical Information, inspects the facility's microfiche duplicating operation.



Hubert E. Sauter has been appointed Director of the Clearinghouse for Federal Scientific and Technical Information at Springfield, Va. Previous to this appointment Mr. Sauter had been Deputy Director at the Clearinghouse since 1965.

The Clearinghouse, a division of the NBS Institute for Applied Technology, furnishes the industrial and technical public with unclassified reports produced by Government-supported research and development in defense, space, nuclear energy, and other national programs.

Mr. Sauter has a degree in electrical engineering from Marquette University and a degree in library science from the University of Wisconsin. He has held offices in the Special Libraries Association and in the American Society for Engineering Education, and is a member of the Association of American Library Schools. In his Government service he has served on various panels of the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology.

NSRDS NEWS

This column regularly reports significant developments in the program of the National Standard Reference Data System. The NSRDS was established in 1963 by the President's Office of Science and Technology to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the National Bureau of Standards through the NBS Office of Standard Reference Data, located in the Administration Building at the NBS Gaithersburg Laboratories.

The Generation and Use of Reference Data

To solve technical problems, scientists, engineers, and technologists require a great deal of technical information or data. Some data are specific to a problem, as the amount of water needed to supply a plant. Other data are not; for example, the density of water or the strengths of materials used in the supply tank. Data of the latter type refer either to intrinsic properties of matter or to uniformly controlled properties of commercial materials. As these data do not change from problem to problem, they can be used and re-used. Thus it is desirable to collect them for ready reference.

Measurement of an intrinsic property of a pure material is usually thought of as a scientific measurement, while measurement of a technologically important property of a material or manufactured item is usually thought of as an engineering measurement. Although there is much overlap and no clearcut separation is possible, a qualitative distinction between scientific and engineering data is valuable because the two types of data are usually generated in different ways and appear in different places.

Scientific data are the results of experimental measurements and appear in the scientific literature. In compiling scientific data for references, the initial selection process is a task of considerable magnitude. Usually, the publications of one of the various abstracting services are employed in the selection process. For an area of any scope at all, such compilation requires the selection of a few hundred individual reports for in-depth scanning from a field of several thousand. For major areas both the number of papers selected and the number available may be 10 times as large.

Additional scanning will probably show that only about half of the selected reports contain pertinent data. Because these data result from different experiments and different methods of approach, they contain variations caused by random fluctuation during the experiments and systematic differences caused by the different methods. To decide what value or average of values represents the closest approach to the inherent property desired requires a high level of knowledge of experimental methods and of the background of theory underlying the measurements, as well as sound judgment. It must be emphasized that critical evaluation of the data in an area is a task of sizable (and rapidly increasing) proportions which requires a high level of competence.

Engineering data are found in company and Government reports, technical sales literature, and specifications, as well as in technical journals. The methods of measurement tend to be highly specified and standardized. The standardization usually results from the deliberations of groups of experts acting under the aegis of some engineering society. Larger variations in structure and composition from sample to sample make intercomparison of data between samples less meaningful. Thus more emphasis must be placed on the design of the measurement method so that it will reflect a technically meaningful set of properties.

The need for technical competence in the compilation of both categories of data is recognized by the scientists and engineers, and a good job of critical evaluation is accepted as a technical contribution. Basically, compilation and evaluation are technical functions of a high order, and therefore are usually done as projects by workers carrying on a full spectrum of technical activities. There are few full-time data evaluators and they must keep in close contact with other types of scientific and technical work to maintain the competence which was a prerequisite for good critical evaluation in the first place. Thus, the evaluation of data is embedded in the matrix of technical activity and cannot generally be separated from it except on a project basis.

The utilization of reference data is at least as difficult to separate from the matrix of technical activity as their generation. Surveys [1,2] have shown that chemists and physicists spend an average of one-third of their time on scientific communication—reading, writing, or talking about scientific matters. No other category of professional

continued

activity occupied as much of their time. Scientific communication did not include business communication which was a separate category in the surveys. It is probable that technical people in general spend more time on scientific communication than on any other single activity. From the nature of scientists' activities, the search for data evidently occupies an important, if unspecified, portion of this time.

The number of scientists, engineers, and technicians in the world is at an all-time high and is increasing rapidly. At the same time, the variety of types of problems being treated in a technical manner is also increasing so that there is a continued demand for technical personnel.

Science and technology are advancing rapidly, not only by expansion of their existing borders but also by intensive investigation within these borders which results in a proliferation of fields. This increased technical activity produces an exponential growth of the technical and scientific literature, and hence of the data contained in it. Approximate figures for the years 1900 and 1950 and extrapolated figures for the year 2000 show this growth in terms of scientific journals and papers: [3]

Date	*Journals*	*Papers*
1900	1,000	100,000
1950	3,000	300,000
2000	10,000	1,000,000

The rising need for critical evaluation cannot be attributed solely to increases in the number of technical personnel and volume of data. As more complex and sophisticated problems are attacked and as theoretical insight penetrates deeper, the standards of quality for acceptable data increase and the tolerance of uncertainty decreases. This increases the demands on the theoretical and statistical capabilities of evaluators. In addition, as data from widely divergent fields are used together, they must be convertible to a uniform basis in terms of definition. These data must also be consistent in the sense that no cumulative chains of error can occur during use which would lead to large errors in derived quantities. The increasing need involves quality as well as variety.

The value of standard reference data is very difficult to determine in terms of the actual investment of time in using such data, in search for it, or in evaluating data in the absence of standard reference data, although the need for and use of reference data is necessarily extensive. Some indirect indications of value are available, however, and certain direct benefits resulting from the use of standard reference data can be identified and, in some cases, evaluated quantitatively.

Five types of direct benefits which result from the availability of standard reference data are:

(1) Saving of otherwise necessary search and evaluation costs.
(2) Avoiding the cost of unknowingly duplicating previously completed experiments.
(3) Minimizing overdesign.
(4) Avoiding incorrect decisions based on incomplete knowledge of the existing data.
(5) More accurate assessment of needs in allocating funds as a result of more accurate understanding of the range and quality of existing data.

The costs of experimental measurements are such that, except for rare cases when the sample material is already available and the apparatus set up, it is preferable to try to find data in the literature rather than to measure them again. As a result, the worker needing data is faced with roughly the same task as the compiler, and must make a literature search. Since the costs of doing this can be estimated, the first category is susceptible to quantitative evaluation.

An incomplete negative search can lead to an unknowing, unnecessary duplication of effort. (It might also be noted that there is no clearcut measure of completeness.) That such duplications occur is well known but difficult to document since there is no natural source for publishing such experiences.

In any design, safety factors are introduced to allow for lack of adequate knowledge. By their nature these safety factors add to the cost of the item being designed, so that the cost can be reduced as more reliance can be put on the data used in the designs. Again, examples of overdesign resulting from inadequate knowledge of the data are not publicized. Incorrect decisions based on incomplete data are not generally publicized either.

Although category (5) is difficult to evaluate quantitatively, its importance in an era of increasing competition for funds is obvious. It should be noted that the evaluation process, which involves a complete evaluation of all possible experimental sources of variability, provides a set of standards for measurements of the highest reliability. This set of standards can then be used by experimental workers to ensure that their measurements are properly controlled and properly reported. Thus the process of critical evaluation acts not only to indicate gaps in the literature but also to set standards for future measurements.

Data Program in the United Kingdom

In the United Kingdom the Office for Scientific and Technical Information (OSTI) within the Department of Education and Science has the responsibility to promote and coordinate reference data activities, and to ensure that these activities complement and do not duplicate work in other countries. It serves as the British equivalent to the NBS Office of Standard Reference Data.

Among its areas of major support activity are:

(1) A Data Centre on Mass Spectrometry, operating at the Atomic Weapons Research Establishment, Aldermaston, Berks. This center is investigating and evaluating

methods of comparing mass spectrometric data on a computer-assisted basis. A comprehensively indexed, computer-searchable file, both of mass spectrometry work and work relevant to mass spectrometry, is being constructed and maintained. The Mass Spectrometry Centre is coordinating its activities with the Mass Spectrometry Data Center at NBS.

(2) X-Ray Crystallography Data Centre at the Chemistry Department, Cambridge University. At present the work of the center is confined to data on organic single crystals. The center is cooperating with the NBS Crystal Data Center whose activities were described in an earlier issue of NSRDS News.[4]

(3) Thermodynamic Properties of Gases Data Centre at Imperial College, London. This activity receives international funding and coordination, and was designed by the International Union of Pure and Applied Chemistry (IUPAC). Many of the developed countries will cooperate in the submission of data to the center which will collect, compile, review, and disseminate the information and data.

(4) Information Centre on High Temperature Processes. Located at the Houldsworth School of Applied Sciences, University of Leeds, this center's work will have two aspects—critical evaluation of rate data on chemical reactions of interest in high temperature work, and experimental investigation of selected reactions which generate such data.

The OSTI is also supporting experimental, specialized information centers of Biodeterioration at the University of Aston-in-Birmingham and on Intestinal Absorption at the University of Sheffield.

NMR Spectroscopy Panel Meeting

An *ad hoc* Panel on Nuclear Magnetic Resonance Spectroscopy met in Washington, D.C., on November 29, 1967, under the sponsorship of the National Academy of Sciences–National Research Council. The panel, led by Bernard L. Shapiro of Illinois Institute of Technology, was convened as a subunit of the National Standard Reference Data System Advisory Panel for Atomic and Molecular Properties, with the goal of recommending data compilation and evaluation activities which would be appropriate for inclusion in the National Standard Reference Data Program.

NMR spectroscopy, a vital analytical and investigative tool for organic and physical chemistry, has been given a high priority for new data compilation activities as part of the atomic and molecular program. Recommendations of the *ad hoc* Panel will be used by the Office of Standard Reference Data in making plans for the coming year.

In its discussions, the Panel recognized the existence of several well-established sources of NMR spectra for reference purposes, and emphasized the need to avoid duplication of effort. The Panel focussed on chemical and structural applications of NMR, rather than its use in solid state and metals physics.

First International CODATA Conference

The First International CODATA Conference will be held at Ev. Akademie Arnoldshain, Taunus Mountains, near Frankfurt/Main, Federal Republic of Germany, June 30 to July 5, 1968.

This Conference is the first in a planned series. It is designed to bring together, from all interested countries and international organizations, compilers and users of numerical data and representatives of organizations and agencies responsible for the establishment and management of data compiling groups and data centers of various types. The Conference will be run on informal lines with morning and evening technical discussions, Monday, July 1, through Friday noon, July 5. The afternoons will be available for organized discussion groups, informal exchanges of information, or recreation. Sunday evening, June 30, will be for registering and getting acquainted.

This type of meeting has proven to be very valuable for exchanging information and ideas in a way not possible at formal scientific conferences. The direct personal contacts established provide a basis for effective collaboration and coordination of activities in different countries and different organizations.

The program will center around the general background of standard reference tables of numerical property values for science and technology; the programs of national governments and international unions in this area; and the methodology, successes, and problems facing compilers in specialized areas such as thermodynamics, spectral data, and nuclear data. Also, working groups, appointed in advance, will present for discussion recommendations regarding coordination among compilers, selection of key values for selected areas of the physical sciences, definitions important to compilers, and so on. The speakers, panelists, chairmen, and participants selected will assure good coverage and discussion of worldwide developments and needs in the field of CODATA. The Conference language will be English.

Attendance at the Conference is by application. Requests for information and application forms for invitations should be addressed to:

Guy Waddington, Executive Director
Central Office, ICSU Committee on Data for Science and Technology
2101 Constitution Avenue, N.W.
Washington, D.C. 20418
U.S.A.

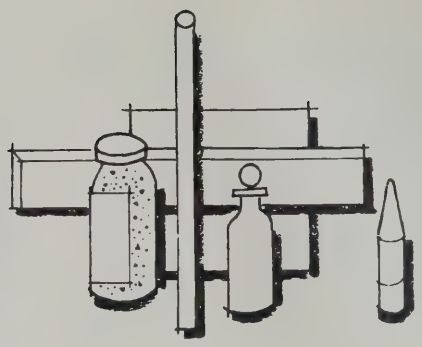
[1] An operations research study of the dissemination and use of recorded scientific information, by Operations Research Group, Case Institute of Technology, Report to Office of Scientific Information, National Science Foundation, Grant No. G–8434, Dec. 1960.

[2] An operations research study of the scientific activity of chemists, by Operations Research Group, Case Institute of Technology, Nov. 1958.

[3] A calculus of science, by D. J. de Solla Price, Intern. Sci. Technol. No. 15, 37 (Mar. 1963).

[4] See NSRDS News, Tech. News Bull. 52, No. 1, 14 (1968).

STANDARD REFERENCE MATERIALS



The NBS Office of Standard Reference Materials has recently issued two new standards for determining the sulfur content in residual fuel oil, as well as five renewal standards, and has revised the certificate of analysis of three gas-in-metal standards to provide additional analytical information.[1]

SULFUR IN RESIDUAL FUEL OIL

Of the many materials now classed as atmosphere pollutants, sulfur dioxide can be detected by human senses in lower concentrations than any other common pollutant. Consequently, it must be classed as one of the more objectionable pollutants, at least from the point of view of the man-in-the-street. At present, there are in force, or under consideration, regulations by various levels of government to control the amount of sulfur dioxide emitted to the atmosphere. These controls may take the form of limiting the sulfur dioxide in smoke and stack gas by means of various scrubbing techniques, or of limiting the amount of sulfur in the fuel.

Of the sulfur dioxide emitted to the air over the United States in 1963 (greater than 23 million tons), about two-thirds stemmed from coal-burning powerplants and another 16 percent from residual fuel oil. The Petroleum Products Survey of the U.S. Bureau of Mines indicates that No. 6 fuel oil sold in the populous Northeastern area ranges from 0.52 percent to 2.9 percent in sulfur content. In the West, the maximum sulfur content exceeds 4 percent. In all probability, after much debate pro and con, there will be limits placed on the amount of sulfur in coal and fuel oil.

To provide a base for accurate analysis of fuel oil, the National Bureau of Standards has certified two new standard reference materials intended for use in the determination of sulfur in residual fuel oil. Designated NBS Standard Nos. 1621 and 1622, the new standards were prepared from commercial fuel oil supplied by the Esso Research & Engineering Co., Linden, N.J.

Sulfur was determined gravimetrically as barium sulfate after combustion in a Parr oxygen bomb using 1-gram samples. The method used is similar to ASTM Method designation D–129. It differed only in that any iron present was removed with ammonium hydroxide before the precipitation of the sulfur as barium sulfate. Analyses for sulfur were made by B. S. Carpenter, R. A. Paulson, and W. P. Schmidt, of the Analytical Chemistry Division, NBS Institute for Materials Research.

The sulfur content of NBS No. 1621 is 1.05 ± 0.02 weight percent and the sulfur content of NBS No. 1622 is 2.14 ± 0.01 weight percent. The uncertainties given on the certificates represent the 95-percent confidence limit of the means based on 30 determinations on each and allowances for known sources of possible error. These standards are issued in units of 100 ml in glass bottles.

CAST IRON STANDARDS

Renewals of two cast iron standard reference materials in chip form have been issued with provisional certificates of analysis for total and graphitic carbon, manganese, phosphorus, sulfur, silicon, copper, nickel, chromium, vanadium, molybdenum, titanium, arsenic, and nitrogen.

Designated NBS Standard Nos. 5L and 6g, the materials are intended primarily for use in checking chemical methods of analysis in the cast iron industry. The demand for cast iron standards has increased in recent years as a consequence of increased production of these important alloys, tighter chemical composition specification within the cast iron industry, and use of new and more rapid analytical equipment which depends on use of standards for its value.

Packaged in glass bottles, the chips are sized to pass a 16-mesh sieve and be retained on a 25-mesh sieve. The chips were milled from thin-wall cylindrical castings prepared using an NBS mold pattern at the American Cast Iron Pipe Co., Birmingham, Ala.

Chemical analyses for certification were obtained in a cooperative program among laboratories of the American Cast Iron Pipe Co., Birmingham, Ala.; Jones & Laughlin Steel Corp., Pittsburgh, Pa.; Rex Chainbelt, Inc., Milwaukee, Wisc.; The Youngstown Sheet & Tube Co., Youngstown, Ohio; and the National Bureau of Standards, Washington, D.C. The standards are supplied in units of approximately 150 grams for $35.50 and $31, respectively.[2]

STANDARD METALLO-ORGANIC COMPOUNDS

The amount of wear on components of an internal combustion engine may be determined by analyzing its lubricating oil for metals. Such analysis is done with the optical emission spectrometer. Accurate predictions of wear or probable failure ordinarily are made on the basis of trends in data accumulated over a period of time from a series of determinations. To assure the accuracy of the analytical work, the spectrometer must be calibrated with standard reference materials.

The Bureau has developed a series of 24 different metallo-organic standards for this purpose at the request of the Division of Refining of the American Petroleum Institute. These standards are stable, oil-soluble to the concentrations needed, and do not absorb excessive amounts of water. They yield solutions in lubricating oils which are constant and which do not precipitate on standing.

The principal users of the metallo-organic standards were at first the railroad and trucking industries. The analysis for metals in lubricating oils was used as the basis for maintenance schedules and predictions of equipment failure. Agencies of the Department of Defense also utilize the metallo-organics for safeguarding equipment and for minimizing maintenance and repair costs. Newer uses include monitoring the presence of catalyst metals and catalyst poisons in process streams.

Three metallo-organic standards for determining metals in petroleum products were recently renewed and certified. They are: NBS Nos. 1016b, Magnesium Cyclohexanebutyrate; 1065b, Nickel Cyclohexanebutyrate; and 1075a, Aluminum 2-Ethylhexanoate. These standards were prepared to fill the need for an adequate collection of standards which could be used to prepare a desired blend of known metal concentration in an appropriate lubricating oil.

These metallo-organic compounds were prepared by Distillation Products Industries, Rochester, N.Y. Further preparative work was carried on by Connie L. Stanley of the Analytical Chemistry Division, NBS Institute for Materials Research. Chemical analyses were made by B. B. Bendigo and E. R. Deardorff; spectrochemical analyses by Virginia C. Stewart, all of the Analytical Chemistry Division.

The standards are supplied in units of approximately 5 grams at a price of $26 per unit.[2] The certificate furnished with each standard gives the amount of the certified metallic element present, as well as directions for preparing a solution of known concentration in lubricating oil.[3]

GAS-IN-METALS STANDARDS CERTIFIED FOR NITROGEN

At the request of metal producers and consumers, the NBS Office of Standard Reference Materials two years ago issued several new iron-base metals certified for their oxygen content. These were intended primarily for calibrating vacuum and inert-gas fusion analytical equipment.

Oxygen values as determined by activation analysis are now available for these standards. Also, nitrogen values were established by a Kjeldahl solution-distillation procedure. These values are reported on new certificates of analysis which have been issued for these materials.

The three steels, NBS Standard Nos. 1090, Ingot Iron; 1091, Stainless Steel; and 1092, Vacuum Melted Steel, are representative of three different steelmaking processes.

The vacuum and inert-gas fusion procedures for analyzing these standards are described in NBS Miscellaneous Publication 260–14.[4] Activation values were determined with the NBS 14-MeV neutron generator and by using the n, gamma reaction. Nitrogen values were obtained using a modified Kjeldahl procedure on millings prepared from the full cross-section of solid-form rods.

The iron-base standards, NBS Nos. 1090, 1091, and 1092, are in the form of rods 4 inches long. Nos. 1090 and 1092 are ¼ inch in diameter and No. 1091 is 5/16 inch in diameter. They may be purchased for $35 each.[2]

Each standard is supplied with a certificate of analysis and with reports which give details on the procedures used in the certification.

Requests for information about the gas-in-metal standards should be directed to the Office of Standard Reference Materials, Room B308, Chemistry Building, National Bureau of Standards, Washington, D.C. 20234.

[1] For a complete list of Standard Reference Materials available from NBS, see **Standard Reference Materials: Catalog and Price List of Standard Materials Issued by the National Bureau of Standards**, NBS Misc. Publ. 260 (1968 ed.), for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 45 cents. Quarterly insert sheets which update Misc. Publ. 260 are supplied to users on request.

[2] These standards may be purchased for the price indicated from the Office of Standard Reference Materials, Rm. B308, Chemistry Bldg., National Bureau of Standards, Washington, D.C. 20234.

[3] **Analytical Standards for Trace Elements in Petroleum Products**, NBS Mono. 54 (1962). Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 25 cents.

[4] **Standard Reference Materials: Determination of Oxygen in Ferrous Materials SRM 1090, 1091, and 1092**, by O. Menis and J. T. Sterling, NBS Misc. Publ. 260–14, for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 30 cents.

PUBLICATIONS of the National Bureau of Standards*

PERIODICALS

Technical News Bulletin, Volume **52**, No. 1, January 1968. 15 cents. Annual subscription: Domestic, $1.50; foreign, $2.25. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $5; foreign, $6. Single copy, $1.

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Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $2.75; foreign, $3.50. Single copy, 75 cents.

CURRENT ISSUES OF THE JOURNAL OF RESEARCH

J. Res. NBS **71A** (*Phys. and Chem.*), No. 6 (Nov.–Dec. 1967), $1.

William Frederick Meggers, A Tribute. K. G. Kessler.

The second spectrum of ytterbium (Yb II). W. F. Meggers. (Edited by C. E. Moore).

An improved description of technetium spectra (Tc I and Tc II), 2000 to 9000 Å. W. R. Bozman, W. F. Meggers, and C. H. Corliss.

Lifetimes of energy levels in neutral iron. C. H. Corliss and J. L. Tech.

Transition probabilities in argon I. C. H. Corliss and J. B. Shumaker, Jr.

The fifth spectrum of praseodymium. V. Kaufman and J. Sugar.

Fundamental energy levels of neutral promethium (Pm I). J. Reader and S. P. Davis.

J. Res. NBS **71C** (*Engr. and Instr.*) No. 4 (Oct.–Dec. 1967), 75 cents.

Measurements of the thermal conductivity and electrical resistivity of platinum from 100 to 900 °C. D. R. Flynn and M. E. O'Hagan.

Thermal conductivity and electrical resistivity of Armco iron. T. W. Watson, D. R. Flynn, and H. E. Robinson.

Heat flow in a right circular cylinder with internal heat generation—Applications to the determination of thermal conductivity. D. R. Flynn.

Radiation-induced acoustic cavitation; apparatus and some results. M. Greenspan and C. E. Tschiegg.

Design of a new Kossel pattern generator. D. L. Vieth and H. Yakowitz.

The near-zone magnetic field of a small circular-loop antenna. F. M. Greene.

J. Res. NBS **72C** (*Engr. and Instr.*), No. 1 (Jan.–Mar. 1968), 75 cents.

Acceleration due to gravity at the National Bureau of Standards. D. R. Tate.

Deflection of thin circular elastic plates under symmetrically distributed loading. A. F. Kirstein and R. M. Woolley.

A dynamic method for determining the vapor pressure of carbon dioxide at 0°C. J. L. Edwards and D. P. Johnson.

An adiabatic saturation psychrometer. L. Greenspan and A. Wexler.

An injection method for self-calibration of inductive voltage dividers. W. C. Sze.

Bolometric voltage and current (Bolovac) standard for high and microwave frequencies. M. C. Selby.

An admittance meter technique to measure the complex permeability at VHF. A. L. Rasmussen and C. M. Allred.

OTHER NBS PUBLICATIONS

A review of studies made on the decade fluctuations in the earth's rate of rotation, W. R. Davey, Tech. Note 358 (Oct. 16, 1967), 20 cents.

Disclosures on: Autosort—an automatic collating and sorting machine, optical heterodyne refractometer, liquid metering pump, stable wideband relaxation oscillator using three inverting amplifiers, and seat belt webbing abrasion resistance testing machine, Eds. D. Robbins and A. J. Englert, Tech. Note 437 (Nov. 1967), 25 cents.

Radiochemical analysis nuclear instrumentation, radiation techniques, nuclear chemistry radioisotope techniques July 1966 through June 1967, Ed. J. R. DeVoe, Tech. Note 421 (Nov. 1967), 50 cents.

Tables of bimolecular gas reactions, A. F. Trotman-Dickenson and G.S. Milne, NSRDS–NBS–9 (Oct. 27, 1967), $2.

Tabulation of data on microwave tubes, J. K. Moffit, Handb. 104 (Sept. 29, 1967), $1.25. Supersedes Handb. 70.

Tabulation of data on receiving tubes, J. K. Moffitt, Handb. 103 (Sept. 29, 1967), $1.25. Supersedes Handb. 83.

The hyperbolic character of certain experimental results which tend toward limiting values, A. F. Kirstein, Tech. Note 435 (Nov. 1967), 15 cents.

PUBLICATIONS IN OTHER JOURNALS

This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.

CHEMISTRY

High-precision coulometric iodimetry, G. Marinenko and J. K. Taylor, Anal. Chem. **39**, No. 13, 1568–1571 (Nov. 1967).

Light scattering phenomena near the critical point, D. McIntyre and A. M. Wims (Proc. 2d Interdisciplinary Conf. Electromagnetic Scattering ICES–II, University of Massachusetts, Amherst, June 28–30, 1965), Book, Electromagnetic Scattering, Eds. R. L. Rowell and R. Stein, pp. 457–484 (Gordon and Breach, Inc., New York, N.Y., 1967).

NMR studies of inorganic fluorides. III. Si_3F_8, R. B. Johannesen, J. Chem. Phys. **47**, No. 3, 955–960 (Aug. 1967).

Periodic acid, a novel oxidant of polycyclic aromatic hydrocarbons, A. J. Fatiadi, Chem. Commun. **21**, 1087–1088 (1967).

Phenylhydrazono-phenylazo tautomerism. Part II. Structures of 2-oxo-1,3-bis(phenylhydrazono) compounds and related compounds, A. J. Fatiadi and H. S. Isbell, Carbohydr. Res. **5**, 302–319 (1967).

ENGINEERING AND INSTRUMENTATION

A new ultra-low-frequency bridge for dielectric measurements, W. P. Harris, 1966 Annual Report, Conf. Electrical Insulation and Dielectric Phenomena, National Academy of Sciences—National Research Council, Mt. Pocono, Pa., 1966, pp. 72–74 (1967).

A 100 Mc/s 2 out of 3 gate, J. K. Whittaker, Nucl. Instr. Methods **45**, No. 1, 138–140 (Nov. 1966).

A single axis, two crystal x-ray instrument, R. D. Deslattes, Rev. Sci. Instr. **38**, No. 6, 815–820 (June 1967).

A testing and rating method for refrigerated trucks with respect to cooling load, P. R. Achenbach, C. W. Phillips, and R. W. Penny, Annex to Proc. Intern. Inst. Refrigeration, Comm. VII, pp. 29–35 (London, England, Sept. 1966).

Air-to-air heat pumps for military housing, P. R. Achenbach, Military Engr. **384**, 270 (July–Aug. 1966).

An improved transportable 10 picofarad capacitor, R. D. Cutkosky and L. H. Lee, Proc. 11e Session, Comité Con. D'Electricité, May 10–12, 1965, pp. 65–66 (May 1965).

Comparison of the Hall-Petch parameters of zone-refined iron determined by the grain size and extrapolation methods, B. W. Christ and G. V. Smith, Acta Met. **15,** 809–816 (May 1967).

Discussion of the paper "Flow in culverts and related design philosophies," J. L. French, J. Hydraulics Div. Am. Soc. Civil Eng. **93,** No. HY1, 85–91 (Jan. 1967).

Ellipsometric errors due to multiple reactions in mica quarter-wave plates, H. T. Yolken, R. M. Waxler, and J. Kruger, J. Opt. Soc. Am. **57,** No. 2, 282–284 (Feb. 1967).

Evaluation of a stark voltmeter, Y. Beers and T. W. Russell, IEEE Trans. Instr. Meas. **IM–15,** No. 4, 380–388 (Dec. 1966).

Five years of VLF worldwide comparison of atomic frequency standards, B. E. Blair, E. L. Crow, and A. H. Morgan, Radio Sci. **2,** No. 6, 627–636 (June 1967).

Improved transfer standard for vibration pickups, E. Jones, D. Lee, and S. Edelman, J. Acoust. Soc. Am. **41,** No. 2, 354–357 (Feb. 1967).

Introduction, J. M. Richardson (Proc. 1966 Conf. Precision Electromagnet Measurements, Boulder, Colo., June 21–23, 1966), IEEE Trans. Instr. Meas. **IM–15,** No. 4, 138 (Dec. 1966).

Machine oriented fingerprint classification system, J. H. Wegstein and J. F. Rafferty (Proc. 1st Natl. Symp. Law Enforcement Science and Technology, Chicago, Ill., Mar. 7–9, 1967), Book, Law Enforcement Science and Technology, Vol. 1, Ed. S. A. Yefsky, Chapt. V, Information Storage and Retrieval, pp. 459–465 (Academic Press Inc., New York, N.Y., 1967).

Performance criteria for building components and systems, P. R. Achenbach, Proc. Porcelain Enamel Institute Forum, University of Illinois, Urbana, Ill., Sept. 28–30, 1966, **28,** 176–195 (1966).

Stress-corrosion cracking of cold-reduced austenitic stainless steels, H. L. Logan and M. J. McBee, Mater. Res. Std. **7,** No. 4, 137–145 (Apr. 1967).

The Bi I–II transition pressure measured with a dead-weight piston gauge, P. L. M. Heydemann, J. Appl. Phys. **38,** No. 6, 2640–2644 (May 1967).

The RF connector, R. C. Powell, Microwave J. **10,** No. 3, 69 (Feb. 1967).

Transistorized current stabilizer for x-ray tubes with directly heated cathodes, K. W. Yee and R. D. Deslattes, Rev. Sci. Instr. **38,** No. 5, 637–638 (May 1967).

Two-crystal, vacuum monochromator, R. D. Deslattes, Rev. Sci. Instr. **38,** No. 5, 616–620 (May 1967).

MATHEMATICS

Anniversaries in 1966–67 of interest to statisticians. Part II: Tercentennials of Arbuthnot and De Moivre, C. Eisenhart and A. Birnbaum, Am. Stat. **21,** No. 3, 22–29 (June 1967).

Comparison of three spin algebras employed in SU(6) theories, R. C. Casella, Phys. Rev. **147,** No. 4, 962–964 (July 29, 1966).

Computer aided typesetting, W. R. Bozman, Book, Advances in Computers, Vol. 7, Chapt. 4, 195–207 (Academic Press Inc., New York, N.Y., 1966).

Curve-fitting techniques and applications to thermodynamics, J. G. Hust and R. D. McCarty, Cryogenics **7,** No. 4, 200–206 (Aug. 1967).

Fundamental polygons for Fuchsian groups, L. Greenberg, J. Anal. Math. **18,** 99–105 (1967).

Fundamental polyhedra for kleinian groups, L. Greenberg, Ann. Math. **84,** No. 3, 433–441 (Nov. 1966).

Invariance of the homology of a lattice, J. Mather, Proc. Am. Math. Soc. **17,** No. 5, 1120–1124 (Oct. 1966).

On a theorem of Ahlfors and conjugate subgroups of kleinian groups, L. Greenberg, Am. J. Math. **LXXXIX,** No. 1, 56–68 (Jan. 1967).

METROLOGY

A comparator for thermal AC–DC transfer standards, R. S. Turgel, Proc. 21st Annual ISA Conference and Exhibit, New York, N.Y., Oct. 24–27, 1966, ISA Preprint 12.3–1–66 (Oct. 1966).

An intercomparison of hydrogen and cesium frequency standards, R. Vessot, H. Peters, J. Vanier, R. Beehler, D. Halford, R. Harrach, D. Allan, D. Glaze, C. Snider, J. Barnes, L. Cutler, and L. Bodily, IEEE Trans. Instr. Meas. **IM–15,** No. 4, 165–176 (Dec. 1966).

Application of computers to quantitative analysis of microstructures, G. A. Moore, Book, Proc. 2d Intern. Congress for Stereology, Chicago, Ill., Apr. 8–13, 1967, Ed. H. Elias, pp. 281–284 (Springer-Verlag, New York, N.Y., 1967).

Calibration of germanium thermometers from 2° to 20°K, G. Cataland and H. H. Plumb (Proc. Intern. Inst. Refrigeration, Commission 1, Boulder, Colo., 1966, Annexe 1966–5), Suppl. Bull. Inst. Intern. Froid, pp. 153–163 (Louvain, Belgium, 1966).

Calibration of the NBS photoelectric pyrometer of 1961, R. D. Lee, Proc. 7th Session, Comité Con. de Thermométrie, Paris, France, pp. 74–78 (Sept. 24, 1964).

Cryogenic thermocouple thermometry, L. L. Sparks and R. L. Powell, Meas. Data **1,** No. 2, 82–90 (Mar.–Apr. 1967).

International standardization and expanded world trade, A. V. Astin, Mag. Std. **37,** No. 7, 191–194 (July 1966).

Interval scales, ratio scales, and additive scales for the sizes of differences perceived between members of a geodesic series of colors, D. B. Judd, J. Opt. Soc. Am. **57,** No. 3, 380–386 (Mar. 1967).

On long-term stability of Zener reference diodes, W. G. Eicke, Jr., and H. H. Ellis, Proc. 11e Session, Comité Con. D'Electricité, May 10–12, 1965, pp. E-73—E-77 (May 1965).

Potential applications of the x-ray/density method for the comparison of atomic-weight values, R. D. Deslattes, H. S. Peiser, J. A. Bearden, and J. S. Thomsen, Metrologia **2,** No. 3, 103–111 (July 1966).

Reflectance spectrophotometry, D. B. Judd, Encyclopedia of Industrial Chemical Analysis **3,** 376–392 (John Wiley and Sons, Inc., New York, N.Y., 1966).

Review of elementary theory of the photometry of projection apparatus, C. S. Douglas, Illum. Engr. **62,** No. 4, 246–253 (Apr. 1967).

Statistical concepts in metrology, H. H. Ku, Book, Handbook of Industrial Metrology, Chapt. 2, pp. 20–54 (Prentice-Hall, Inc. Englewood Cliffs, N.J., 1967).

The metric system in Illuminating Engineering, L. E. Barbrow, Illum. Engr. **57,** No. 11, 638–640 (Nov. 1967).

The photometry of colored light, A. C. Wall, Illum. Engr. **62,** No. 4, 239–242 (Apr. 1967).

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